MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2016/2017

EBT3036 – MEDICAL IMAGING

(BE)

24 FEBRUARY 2017
9.00 a.m – 11.00 a.m
(2 Hours)

INSTRUCTION TO STUDENT

1. This Question Paper consists of 5 pages with 4 Questions only.

2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.

   a) Please write all your answers in the Answer Booklet provided.

QUESTION 1

a) Define what radionuclide is and give one example of radionuclide from Carbon family. [2+1 marks]

b) State the four types of radioactive decays. What types of decays are used for SPECT and PET imaging, respectively? [4+2 marks]

c) Suppose we have 2×10^{12} Technetium-99m (Tc-99m) atoms to start with. Given the half-life for Tc-99m is 6 hours.

i) What is the radioactivity of Technetium-99m at t=0? [2 marks]
ii) Determine how long will it take for the original activity of the Technetium-99m atoms to decay to activity 1 mCi. [6 marks]

d) One of the desired properties of a radiotracer is that it needs to be a safe and useful tracer for a human body. Explain the other four desired properties of a radiotracer. [8 marks]

Continued...

QUESTION 2

a) Give the frequency range for medical ultrasound imaging. [2 marks]

b) Consider an acoustic wave encounters a muscle/bone interface at normal incidence. The acoustic impedance of muscle is 1.7×10^5 $gcm^{-2}s^{-1}$ and the acoustic impedance of muscle is 7.8×10^5 $gcm^{-2}s^{-1}$.

i) Determine the fraction of the acoustic intensity that is reflected back from the muscle/bone interface. [4 marks]

ii) What is the transmitted intensity in this case? [2 marks]

c) A 5 MHz ultrasound transducer is pointing down to the +z axis. At time t=0, it generates an acoustic pulse in the form of:

$$\phi(t) = \left(1 - e^{-t/\tau_1}\right) e^{-t/\tau_2}$$

i) Write down the equation of the forward travelling wave down the +z axis. [2 marks]

ii) Assuming the acoustic pulse travels from the face of the transducer through 1 cm layer of fat before going into a liver. At what time does the leading edge of the impulse hit the first interface? The speed of sound in fat is 1450 ms^{-1}. [3 marks]

iii) Explain the attenuation processes that act on the acoustic pulse from the moment it leaves the face of the transducer until an echo is received. [12 marks]

Continued...

QUESTION 3

a) Discuss the main principles in Nuclear Magnetic Resonance (NMR). [6 marks]

b) Explain the functions for each of the five main components of an MRI scanner as given by **Figure Q3.1** below. [10 marks]

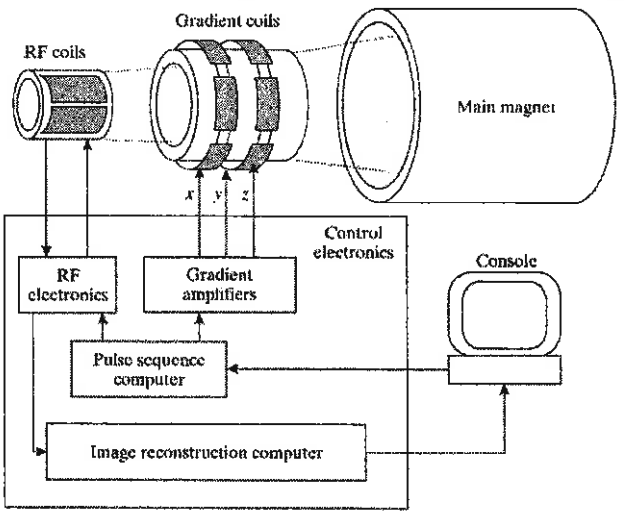

Figure Q3.1

c) The basic NMR signal is a sinusoid at the Larmor frequency. Explain the factors that affect the magnitude of an NMR signal. [9 marks]

Continued...

QUESTION 4

a) Briefly explains four importance of photon absorption in biomedical optics. [8 marks]

b) **Figure Q4.1** below shows a photon trajectory before and after a scattering event. Discuss the relationship between anisotropy, scattering coefficient and reduced scattering coefficient. [10 marks]

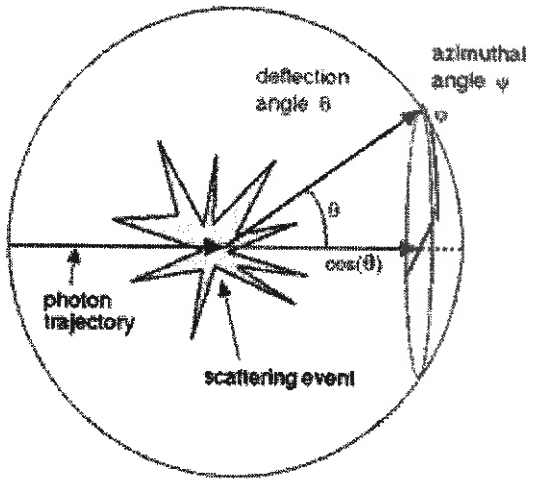

Figure Q4.1

c) Given the transmitted ratio of an optical photon after penetrated 150 μm of soft tissue is 1%. Determine the total attenuation coefficient of the soft tissue and the corresponding mean free path of the optical photon propagating in the soft tissue. Ignore the effect of specular reflection. [7 marks]

End of Paper